Understanding Broadband Deployment in Vermont

February 2007

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Preface

This report was originally prepared in draft form as a discussion paper for circulation to key stakeholder groups and others as part of the process of responding to the legislative requests to the Department of Public Service related to broadband service contained in Act 172 of the 2005-2006 legislative session, and the May 9, 2006 letter from the Chairs of the House Commerce Committee, the Senate Finance Committee, and the Senate Economic Development, Housing, and General Affairs Committee. That draft attempted to describe the factors advancing the development of broadband service in Vermont, and those factors keeping the state from universal availability of the service. Based on the comments that the Department has received, based on a survey of state agencies and departments on policies and regulations affecting broadband also performed in response to Act 172, and based upon further analysis, we have revised and expanded that draft and present the results here. Together with a companion document, *Access for All: Meeting Vermont's Broadband and Wireless Goals*, it constitutes the Department's response to the reports requested by the legislature through Act 172 and the May 9, 2006 letter for submission by January 15, 2007. This report assesses the current state of affairs and trends related to broadband. *Access for All* provides a summary of key state policy factors affecting broadband deployment and makes recommendations for advancing Vermont toward the goal of universal availability of broadband and wireless services.

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Introduction

Bringing advanced telecommunications services within the reach of all Vermonters is a key goal of our state. Governor Douglas has set a goal that cellular and broadband service be available throughout the state universally by 2010. In this paper, in order to understand the state of broadband deployment in Vermont, we endeavor to analyze the broadband landscape. There are several variables involved in our analysis. We will look at technologies, costs, demographics, financing, competition and regulation. This analysis is a foundation for understanding why broadband availability is where it is today, and how to move forward.

We have made progress toward achieving our broadband goals, but there are still critical gaps. The most recent Department of Public Service estimates indicate that more than 85 percent of Vermonters have access to at least one mass-market broadband service. The FCC reports that there were 88,317 residential high-speed subscriptions in Vermont as of December 31, 2005. Internal DPS estimates put Vermont at over 100,000 high-speed lines as of June 2006. Even though Vermonters are rapidly adopting high-speed Internet connections, the most rural Vermonters are proving the hardest to reach. We believe it is important to analyze available information in order to determine how best to encourage broadband deployments to these areas.

High Speed Lines by State

Over 200 kbps in at least one direction (Business and Residential)

	2002		2003		2004		2005	
State	Jun	Dec	Jun	Dec	Jun	Dec	Jun	Dec
VT	29,990	32,814	39,773	44,724	56,033	72,400	82,259	95,901
ME	61,406	73,061	85,615	99,200	124,191	142,735	176,816	214,599
NH	86,200	102,590	118,879	149,180	168,652	215,862	238,502	268,128
MA	583,627	679,084	821,135	919,638	1,024,732	1,144,146	1,235,672	1,431,759
NY	1,460,894	1,725,296	1,997,340	2,262,804	2,464,342	2,808,553	3,188,033	3,660,500
USA	16,202,540	19,881,549	23,459,671	28,230,149	32,458,458	37,890,646	42,866,469	50,237,139

High-Speed Services for Internet Access: Status as of December 31, 2005

Broadband in Vermont

The growth in high-speed access lines in Vermont has kept pace with national trends and does not appear likely to slow. The Department of Public Service has worked with the companies that provide broadband service in an effort to map the availability of broadband services throughout the state. Estimates of broadband availability by type of service are used in conjunction with home and business location data in order to produce estimates of broadband availability in Vermont.

The most recent Department of Public Service estimates indicate that between 85 and 90 percent of Vermonters have access to at least one mass-market broadband service. At the county level, the degree of broadband availability varies widely. In Rutland, Washington, Grand Isle and Chittenden Counties (see the table below), at almost 95 percent of the population or more has access to some type of broadband service (although there are significant differences in the availability of different types of broadband service available). In Essex and Orange Counties, on the other hand, DSL, cable and fixed wireless broadband services are available to less than half

and two thirds of the population, respectively. In Windham, Franklin, and Lamoille Counties, almost a quarter or more of residents do not have access to one of these broadband services.

Types of available broadband services vary greatly in Vermont. In some counties, one form of service is predominantly responsible for a county's level of service availability. For example, Grand Isle's relatively high broadband availability is due in great part due to the recent introduction of WISP service to the islands, while Addison County has one of the highest rates of DSL availability in the state, which makes a major contribution to its overall broadband availability. In many counties, areas which are served may be served by more than one provider. On the other hand, Orange County has relatively little overlap in the availability of cable modem, DSL, and WISP services.

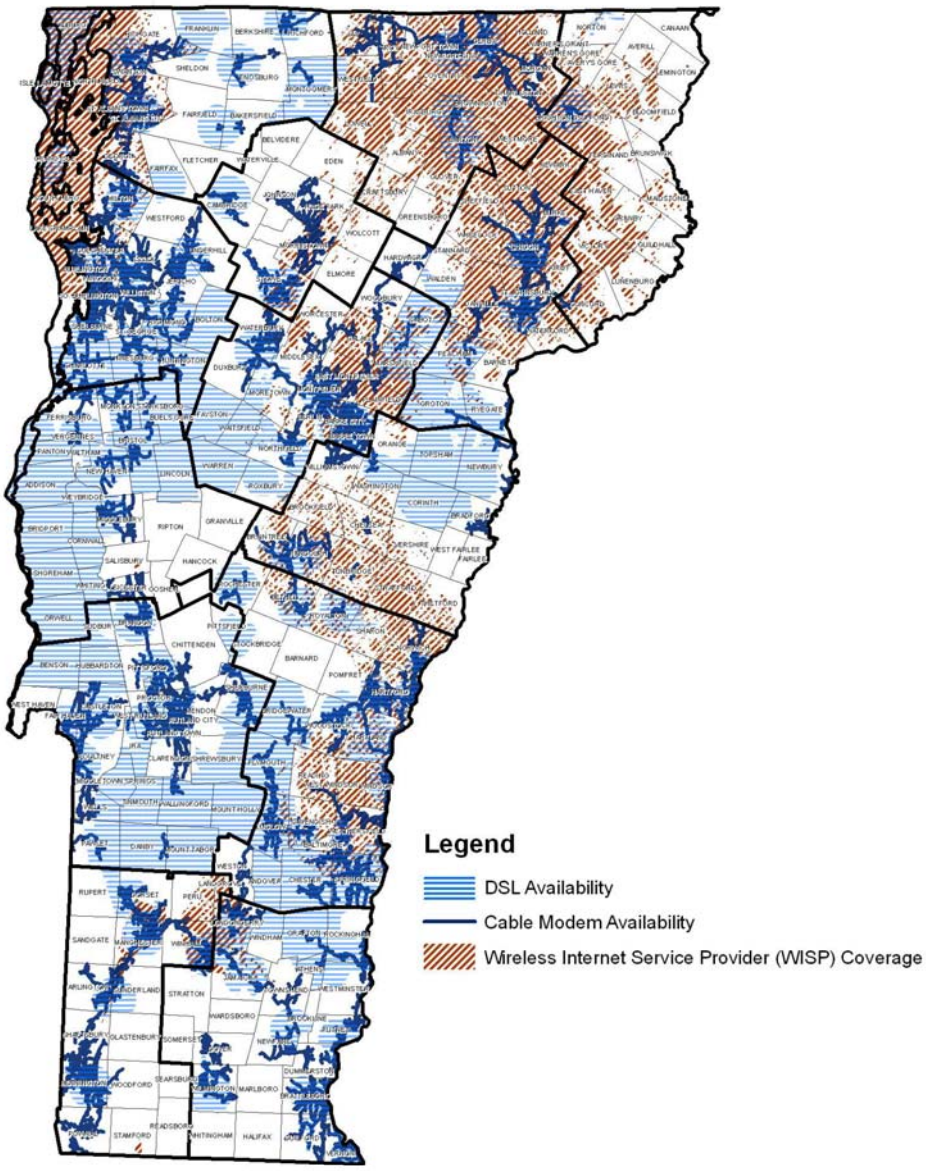
Estimated Residential Broadband Availability in Vermont As a Percentage of Population—2006[1]

County	Cable Modem Availability	DSL Availability	WISP Availability[2]	Total Broadband Service Availability
Addison	50%	83%	0%	90%
Bennington	78%	60%	10%	86%
Caledonia	59%	50%	57%	85%
Chittenden	89%	82%	29%	97%
Essex	21%	20%	28%	41%
Franklin	58%	60%	41%	78%
Grand Isle	0%	63%	92%	97%
Lamoille	54%	25%	32%	68%
Orange	33%	33%	14%	62%
Orleans	52%	44%	69%	86%
Rutland	76%	86%	0%	95%
Washington	73%	76%	11%	94%
Windham	64%	67%	3%	78%
Windsor	66%	75%	31%	89%
Statewide	68%	69%	24%	87%

[1] Availability is based on map and other information reported to the state by service providers. Cable information is based on availability as of the end of year 2005. DSL and WISP information is based on information reported at various times by companies between August and mid-December 2006. In some counties, cable modem, WISP, or overall broadband availability shown is lower than that reported in prior PSD reports. This does not reflect an overall reduction in actual broadband availability in any county, but instead revised reports on the extent of existing broadband availability by WISPs or cable companies, or the correction of errors in prior reports.

[2] Not all WISPs operating in Vermont have submitted service availability information suitable for inclusion in these estimates by the time of publication. Zero percent availability of WISP services shown for Rutland and Addison Counties does not reflect the availability of services from WISPs believed to be operating in these counties.

Approximate Broadband Availability in Vermont



* Cable modem coverage is based on cable company annual report filings through 2005.

* DSL coverage is through November 2006. DSL coverage includes ILEC and CLEC coverage areas. Verizon-area coverage is estimated and may over- or understate the geographic area served.

*Wireless ISP coverages are radiofrequency propagation estimates, where available.

Map Produced 1/9/2007

Broadband Technologies

There are a number of technologies that provide access to High-Speed Internet, but access through cable television and telephone companies' wires is by far the most widespread. Local telephone and cable television companies sell the majority of broadband access at the national level. According to recent estimates, cable modem service and DSL subscribers each comprised about 24 percent of Internet users[3] nationally while 50 percent continue to use dial-up access, and one percent of Internet users subscribe to satellite Internet services. Here, we offer a brief description of various broadband technologies.

DSL

Local telephone companies provide broadband Internet service over the high frequency portion of copper telephone lines. This type of Internet access is called Digital Subscriber Line or DSL. Residential DSL lines commonly offer download speeds of 1.5 Mbps, though higher- and slower-speed services are also available. An unfortunate limitation of DSL is that each deployment can typically only serve customers within an approximate range of 15-18,000 feet of the telephone company central office or remote terminal[4]. DSL customers make up approximately half of all broadband subscribers.

Cable

Cable television companies commonly deploy broadband Internet service alongside television on a coaxial cable. This type of Internet access is referred to as cable modem service. Cable modem service commonly offers download speeds of 3-5 Mbps or higher, and, once a cable system is upgraded, is offered to essentially all locations that can get cable television. About half of broadband subscribers use a cable modem service.

Satellite

Vermonters with a clear view of the southern sky have the potential to receive satellite-based broadband services. Nationally, one percent of Internet subscribers connect via satellite. Satellite Internet's low rate of adoption nationally is arguably related to the shortcomings of satellite-based Internet service; it is substantially more expensive than terrestrial alternatives and is not well suited for latency-sensitive applications. The price of Internet access via satellite is substantially higher than cable or DSL and typical download throughput is significantly lower. Because satellite Internet communications must travel to and from an orbiting satellite, an up to ¾ second delay can interfere with time sensitive Internet applications such as VoIP (Voice over Internet Protocol).

Fixed Wireless

Licensed and unlicensed radio frequencies are being utilized in increasingly creative ways in order to deliver broadband Internet access, especially in rural areas. A wireless Internet provider places equipment atop towers or other high points in an area, similar to mobile telephone operators. However, customers are served at fixed locations. Wireless Internet customers must either rent or purchase antennas to connect to the wireless access point. Though a wireless provider can forgo bringing cables to each of its customers, customer premise equipment is

[3] From a recent Government Accountability Office report to Congress, GAO-06-426
[4] This follows the length of the telephone wire, which is not necessarily a direct path to the customer.

substantially more expensive than DSL or cable options, and service often requires a radio signal (not visible) line of sight path to the provider's access point. Speed of service varies widely depending on the provider. A recent Pew study estimates that 6 million Americans have wireless broadband connections[5].

Fiber

Fiber networks enjoy tremendous bandwidth allocations and can be deployed to distant locations with little signal degradation. The bandwidth is so great that customers are able to receive television, Internet and voice services all over the same fiber connection with plenty of room to spare. Because of relatively large upfront investment required, fiber-only deployments have not been a popular solution to date for very remote homes and small businesses. Fiber can be deployed to varying depths so that it reaches to the neighborhood (FTTN) or all the way to a customer's home (FTTH). Combinations of fiber, copper and wireless are being pioneered, which bring down the cost of deployment by using fiber as a piece of an incumbent's network.

Mobile Wireless

A relatively new player in broadband is access over the networks of wireless telephone providers. The newest of the technologies that are now being deployed is called 1x Evolution-Data Optimized, abbreviated as EV-DO or 1xEV-DO. EV-DO networks are much faster than the so-called 1xRTT networks they evolved out of, offering maximum upload and download rates of 1.8 Mbps and 3.1 Mbps respectively. Deployment of both 1xRTT and EV-DO is relatively small in Vermont at this time, but between June and December of 2005 total connections in the U.S. increased from 379,000 to 3.1 million. Mobile wireless high speed access represented less than one percent of total connections nationally in June 2005, and greater than 6 percent by December 2005. Many of these connections could be PDA devices such as Blackberries.

Availability of Broadband Internet Access

Connecting rural locations to a faster Internet can be a big challenge. Much of Vermont is rocky and mountainous, which can increase the cost of connecting rural communities, especially over long distances. Low customer-per-mile-ratios also discourage investment in bringing broadband networks to the most remote areas.

Overall Deployment

There is quite a bit of broadband deployed in Vermont, though the networks overlap, and no one network is ubiquitous. Most cable companies in the state provide broadband Internet access across their whole network. However, networks may not serve every house or road in a given community. The public switched telephone network reaches most Vermonters, even in remote areas, but economic and technical barriers prevent ubiquitous DSL availability over this network. Unfortunately, the broadband technologies used by telephone companies are limited by distance, and the costs of deployment are not trivial.

[5] Pew Internet & American Life Project report – *Broadband Adoption 2006*. This survey estimates that broadband connections are split as follows: 50 percent DSL, 41 percent Cable Modem, 8 percent Fixed Wireless, one percent Satellite.

Telephone Company Deployment

Broadband deployment is varied for different categories of telephone companies in Vermont: Verizon, Independent Telephone Companies, and Competitive Local Exchange Carriers. Vermont's Independent Telephone Companies have excellent broadband coverage in their areas.[6] Vermont's Independent Telephone Companies have deployed DSL to nearly all of their customers, but still haven't reached some far-flung Vermonters. Verizon serves approximately 82 percent of the state's residential wireline telephone customers, but as of early 2006, only 56 percent of its access lines were DSL capable, leaving substantial areas of the state uncovered by broadband. Sovernet and Burlington Telecom offer competitive broadband alternatives, but competitive companies such as these compete almost exclusively in limited portions of the areas where Verizon also offers broadband.

Fiber is currently being deployed by Verizon in its more populated territories such as the New York City metro area. Verizon has stated that it has no foreseeable plan to deploy fiber in Vermont. Burlington Telecom is deploying FTTH in Burlington and Vermont Telephone Company has deployed fiber in Springfield, VT.

Rural v. Urban Deployment

Vermont is a very rural state. Places with greater populations tend to have greater access to affordable broadband, because there are simply more customers to serve. According to a recent GAO report[7], it is more costly to serve rural areas with low population density and rugged terrain. A Pew survey estimates 42 percent of Americans have high-speed Internet in the home, only 25 percent in rural areas[8]. By way of contrast, 94.5 percent of Vermonters subscribe to telephone service[9]. In addition to higher costs of deployment over rough terrain, low population density in rural areas has a great effect on deployment. A reality of the market is that a broadband provider cannot expect to serve each home or business that it can reach, which makes more populous areas a safer target.

General Comparison of Broadband Options

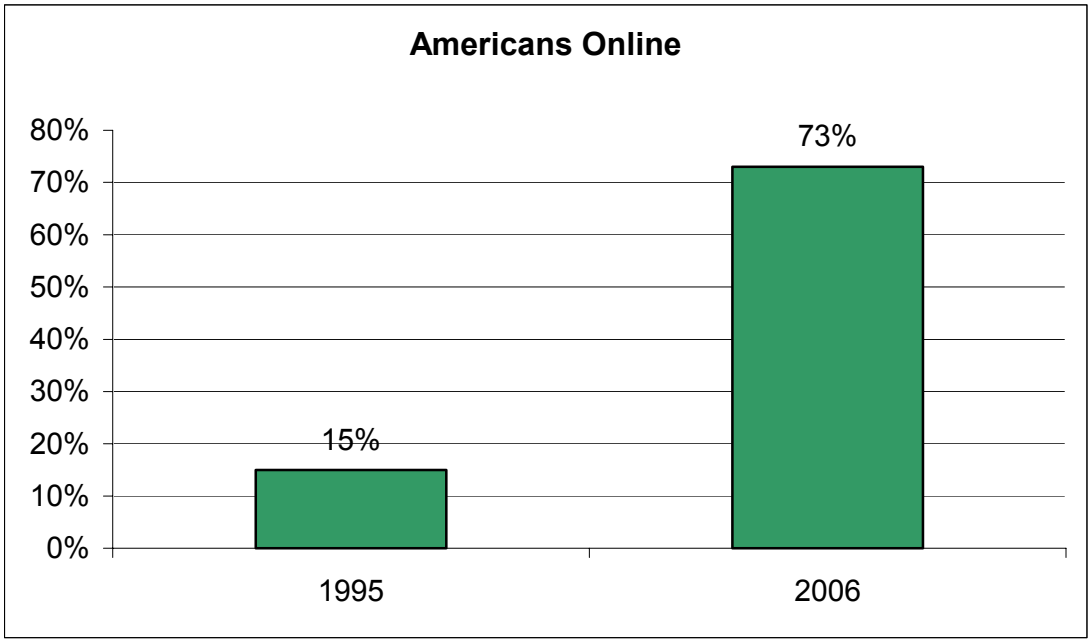
As discussed, there are a variety of different technologies that provide access to the Internet. These factors play a role in decisions by consumers, project managers and investors.
Each technology has different advantages and disadvantages. The chart below is intended to be a general comparison of available Internet technologies. It reflects the characteristics of the services from a range of providers in the market at the present time, and does not necessarily reflect the all the characteristics of any particular provider's service.

[6] These companies were the original monopoly providers of telephone service, other than the Bell System companies, or the successors in ownership to those companies. They are called "independent" because they were not owned by AT&T, unlike New England Telephone, now a part of Verizon.
[7] GAO-06-426 *Broadband Deployment is Extensive throughout the United States, but it is Difficult to Assess the Extent of Deployment Gaps in Rural Areas.*
[8] The Pew study estimates that 73 percent of Americans are Internet users, 13 percent more than the GAO report.
[9] From the FCC report *Telephone Subscribership in the United States,* released May 2006. Ibid.

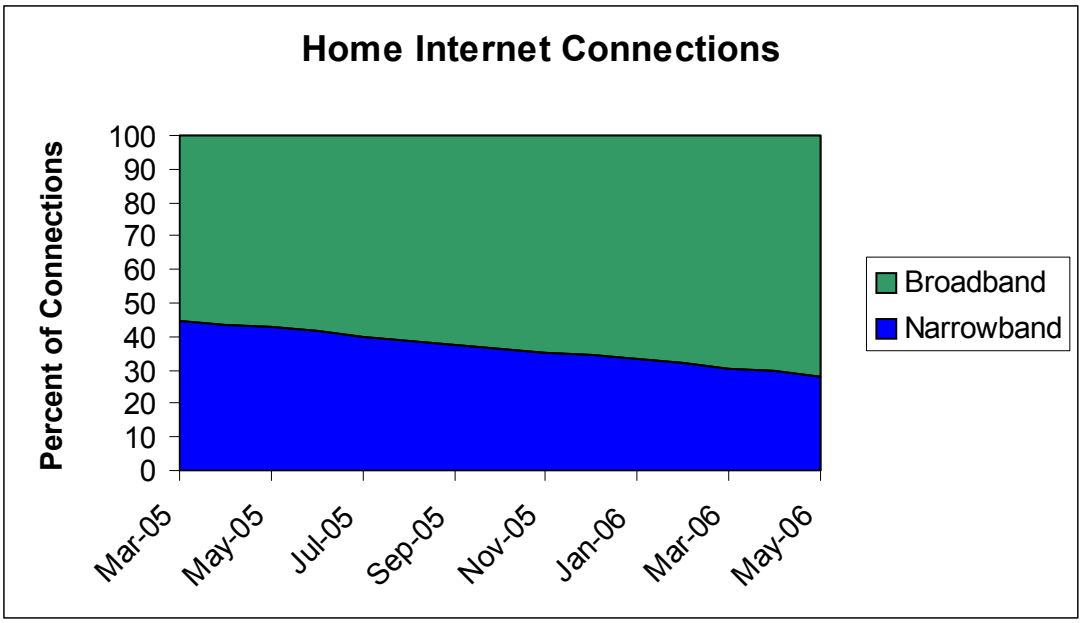
	Investment Cost	Speed	Price/Mo.	Availability	Quality
Fiber	High	Great	$10-50	Poor	Great
DSL	Medium	Good	$18-40	Good	Good
Fixed Wireless	Low	OK-Good	$30-50	OK	OK-Good
Satellite	Low	OK	$50-80	Great	Poor
Mobile Wireless	Medium	OK-Good	$40-80	OK	OK
Cable	Medium	Good	$30-50	Good	Good

Demand for Broadband Internet

The Internet is a relatively new form of communication, yet its rate of adoption has been dramatic. In 1995, about 15 percent of the US population had ever used a computer to connect to a bulletin board or other information service. Now it is estimated that 73 percent of Americans access the Internet[10].



[10] Pew Internet and American Life Data Memo of April 2006, http://www.pewinternet.org/pdfs/PIP_Internet_Impact.pdf .



Source: Nielsen estimates June 2006

In the Internet's beginning, most Americans used dial-up modems to access the Internet, but that is quickly changing. Momentum for broadband Internet services has also built quickly. According to Pew estimates, in June 2000 less than 5 percent of Americans had a broadband connection at home[11]. Nielsen now estimates that 72 percent of present home Internet users are on broadband connections[12].

For Broadband, First, You Need a Computer

One fairly obvious factor affecting broadband penetration is whether there is a computer in the house. Homes with computers are a good target for broadband services, though it appears a small but significant percentage of those households are not Internet users. The majority of those who forgo the Internet do not have computers in their homes[13].

Broadband Subscriptions Cost Money

Once you have a computer, you still need to pay for a broadband connection. Price is a significant factor in demand for broadband Internet, and prices are decreasing. A recent Verizon solicitation offers a 768 Kbps DSL service for $18 a month, which is about the cost of a dial-up plan (which transmits at a theoretical maximum of 56 Kbps). According to Pew estimates, broadband is now 8 percent cheaper than in 2004. In February 2004, DSL users paid $38/month and cable modem customers paid $41. By December 2005, DSL users were reporting paying $32/month while cable modem subscribers continued to pay $41/month.

[11] Pew Internet and American Life, Home Broadband Adoption 2006, page 2, http://www.pewinternet.org/pdfs/PIP_Broadband_trends2006.pdf.
[12] Nielsen estimates are from June 2006, found republished at various places including http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=104&STORY=/www/story/06-21-2006/0004385020&EDATE=.
[13] According to the May 2006 GAO report on broadband deployment, 60 percent of Americans are Internet users (presumably with computers) and 8 percent of households have a computer but do not connect it to the Internet.

Rural Demand for Broadband

According to a recent Government Accountability (GAO) report, consumers in rural areas are demanding and subscribing to broadband, but relatively low availability is affecting broadband penetration levels in rural areas. A May 16, 2006, GAO report to Congress on broadband deployment states, "Finally, we find that households residing in rural areas were less likely to subscribe to broadband service than were households residing in suburban and urban areas. Seventeen percent of rural households subscribe to broadband service, while 28 percent of suburban and 29 percent of urban households subscribe to broadband service." The relatively lower penetration rate in rural areas may have more to do with lack of availability than lack of demand for service[14]. According to the May 2006 GAO report on broadband deployment, urban areas were 9 percent more likely to have broadband service available than rural areas[15].

Demographics

Age, income, and education can also help explain the demand for broadband services. Vermonters with higher incomes and education levels are more likely to be Internet users. People over 64 years old are least likely to use the Internet[16]. According to the Government Accountability Office (GAO), high-income households are 39 percent more likely to purchase broadband service than low-income households. The GAO also finds that households with younger people and college graduates are more likely to purchase broadband[17]. Some of this demographic difference may be because younger, educated and relatively well-off people may be more likely to own computers. However, it is important to recognize these influential characteristics in order to better understand broadband demand.

Demand Aggregation

Population density is a key variable of a profitable broadband network. In order to neutralize some of the risk involved in bringing broadband services to a rural area, the Rural Broadband Project of the Vermont Council on Rural Development (VCRD) has set up a statewide registry and numerous community aggregation projects. At the most basic level, community members establish a list of citizens interested in purchasing broadband, along with a map, and use this information to recruit and negotiate with potential broadband providers. The broadband systems resulting from this effort have most often been wireless systems.

These projects have had some success. Of the 33 community broadband projects listed on the rural broadband project's website as of early January 2007, 11 are in varying stages of deploying wireless Internet. Surveys conducted by the VCRD tend to get a 23 percent positive response rate, which comports with the 25 percent rural take rate cited in the recent Pew study[18]. There have been some successful projects, but few of them have achieved universal coverage.

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[14] "Our model indicated, however, that when the availability of broadband to households, as well as demographic characteristics, are taken into account, rural households no longer appear less likely than urban households to subscribe to broadband. That is, the difference in the subscribership to broadband among urban and rural households appears to be related to the difference in availability of the service across these areas, and not to a lower disposition of rural households to purchase the service." – GAO-06-426, page 13.

[15] "For example, urban areas are about 9 percentage points more likely to receive broadband service than are similar rural areas." – Page 84, ibid.

[16] Pulse of Vermont, Vermont Business Roundtable Quality of Life Study 2005, page 15.

[17] GAO-06-426, page 29.

[18] A positive response indicates an interest in subscribing to a broadband Internet service.

The ability to aggregate both the less dense and more dense parts of a community is often important to getting a community project successfully started. Partial deployments of broadband service in the community can make this more difficult. Where a telephone company only serves a central office without additional remote terminals, outlying areas may be left without a broadband option. When a town center is served by cable, there is a risk that a new provider could not pick up enough customers in the outlying areas to justify deployment.

The Challenge of Capital Availability

Obtaining the capital for investment is one of the central requirements to deploy broadband services. Different types of broadband service providers obtain capital from different sources, have differing levels of access to capital, and have different factors that influence their willingness to allocate capital to broadband investments in Vermont. These differences drive different patterns and outcomes in broadband deployment.

National Companies

Large national providers have had the capital resources to deliver on large broadband deployment commitments with the state, but Vermont has not been the most compelling market on its own for capital investment by these corporations. Companies such as Verizon and Comcast obtain their capital on the national capital markets and through revenues generated across the corporation. Capital is allocated to Vermont operations as a portion of the larger corporation's annual capital budget. Evolving business plans that add more service offerings will also affect capital allocation in Vermont. Capital used to upgrade and maintain existing infrastructure can also divert capital from building out to new areas.

Local sources of capital are not regularly utilized by these entities. These larger companies have capital resources across the corporation that dwarf the capital needs of Vermont. However, they are also active in many markets and have many demands, often more profitable than Vermont opportunities, for their overall capital resources. Therefore, within these corporations, capital for Vermont is subject to strong competition.

The Public Service Board can influence capital spending by these companies to the extent regulation creates ongoing obligations. Because of Adelphia's commitment to build approximately 1,000 miles of line extensions, Comcast will be making substantial investments in Vermont. Additionally, Verizon will be making substantial investments in Vermont as a result of its commitment to expand broadband availability to 80 percent of its Vermont access lines by 2010.

Small Telephone and Cable Companies

Small incumbent telephone and cable companies are more likely to have a focus on investment in Vermont, as they are more likely to be owned by people who live in Vermont and also have fewer and smaller markets to serve. These companies have also been significant actors in bringing capital investment to bear on broadband deployment in rural Vermont, although by their small nature, they tend to cover smaller parts of the state. As mostly mature companies, some are more likely to be financed by reinvested profits. They also tend to produce a steady cash flow, and have good access to capital sources such as local banks, private investors, or specialty

lenders such as USDA Rural Utility Services (RUS) loans. Some companies such as Fairpoint and TDS Telecom, which are mid-sized corporations that own collections of small telephone companies, have aspects that are a hybrid of the smallest and largest companies.

Competitive Companies

Competitive Local Exchange Carriers (CLECs) and former dial-up ISPs (Internet Service Providers) may have obtained an early round of private capital or IPO investment at the time of the Internet bubble. Since then, investment by these companies has frequently been based on "success-based" financing—capital is only available for projects that can demonstrate payback within a very short period of time, such as 18 months. While some of these companies that were founded in Vermont and still operate here have made investments to serve residential customers, especially in the larger cities and towns, mostly this group of providers has focused on business broadband and telephone service. This sector is undergoing rounds of consolidations (Atlantic TeleNetwork buys Sovernet, Level 3 buys Telcove, CTC buys Lightship) funded by a new round of investors. It is unclear if new ownership will provide the acquired companies a greater ability to make longer-term investments.

Local Wireless Providers

Small local Wireless Internet Service Providers (WISPs) have been a sector with extreme capital challenges. These companies are small start-ups with a focus on investing in small areas of Vermont, often in rural or unserved markets. They are often financed by their owner or a small number of private individuals with only limited financial resources. Loans, if obtained, are often secured by the owner's personal assets, which limits the amount of total capital available. There is often little initial revenue to finance continued expansion or provide assurance to lenders or investors. While these companies have invested in broadband in some of the most difficult-to-serve parts of the state, lack of capital has limited the rate of growth and expansion, and many are on shaky financial footing.

USDA Broadband Programs

The United States Department of Agriculture (USDA) has a loan and a grant program designed to help bring broadband to unserved areas. There are currently two USDA Rural Utility Services (RUS) broadband programs: a grant program and a loan program.

The loan program is an open program that has been ongoing for 6 years. To date, the broadband loan program has made around 57 loans that total approximately $871 million. The *Community Connect* broadband grant program is funded at $9 million, and is extremely competitive. Thus far, no Vermont communities have benefited from these programs.

The RUS has established standards that require telephone company infrastructure financed by its telecommunications infrastructure loans to be broadband-capable. However, the RUS is known for being conservative in its lending criteria. Congress has provided the agency with more than a billion dollars for a broadband loan program that may be lent to providers even if they are not its traditional telephone company constituency. Unfortunately, no Vermont company has obtained financing through the program. Barriers service providers have cited include a requirement that companies have on hand a years' worth of operating capital if they have not had a long history of providing service.

VEDA Financing

The Vermont Economic Development Authority (VEDA)[19] administers the Technology Infrastructure Fund (TIF) and has made available close to $2 million in below market interest rate loans as part of the TIF Program. The TIF Program can make loans of up to $1 million and was designed to aid the development of advanced technology infrastructure in Vermont.

The program is currently run through VEDA's Subchapter 5 program, in which monies may only be loaned for fixed asset acquisition. These criteria have not favored Wireless Internet Service Providers (WISPs), which tend to be small start-ups in need of equity and/or working capital. In addition, WISP network assets depreciate rapidly and do not constitute good collateral. The TIF program has also been criticized as having a lengthy application process and as being unable to take sufficient risk. Nevertheless, VEDA has made loans to creditworthy applicants. The TIF program has loaned $1,719,604, as of mid-2006.

State Grants

A grant program was established by the state[20] in partnership with the Agency of Commerce and Community Development, the Department of Information and Innovation, the Vermont Sustainable Jobs Fund, the Vermont Council on Rural Development, and the Vermont Broadband Council. The program provides grants to communities that do not have, or likely are not able to financially afford, broadband service.

The program is funded through the capital budget, with $550,000 cumulatively appropriated in fiscal years 2005-2007, and has thus far awarded grants to twelve Vermont towns[21]. Grants are limited to not more than $50,000 per application. Because of the small size of the grants and the criteria of the program, which favor proposals that can cover large portions of a town, all awards to date have been for wireless broadband projects. The grant sizes have not been large enough to eliminate large gaps in broadband coverage.

Other than the size of grants, this has been some of the most flexible money available for investments in rural broadband in Vermont, relatively speaking, and anecdotal evidence suggests that the state's broadband grant program has activated a lot of communities even if it hasn't provided sufficient financial assistance. There has been some criticism of the program for delays in the award of money, which has been driven in part by the need to grant the money to towns, which re-grant it to other entities.

Municipal Financing

Municipally facilitated financing has been used in the development of Burlington Telecom. The city financed the construction of a fiber network to city and school locations throughout Burlington and the hiring of an operations staff by re-directing dollars that were being spent on the purchase of telecommunications services. The expansion of the network to residential locations is financed through a capital lease provided by the private company Koch Financial, payment of which is backed by revenues from the network.

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[19] VEDA is a Public Instrumentality of the State of Vermont, not a state agency or department.
[20] Act 43 – Public Acts, 2005 Session, Section 35: Broadband Development; Competitive Program.
[21] Brandon, South Hero/Grand Isle, Westmore, West Windsor/Reading, Lowell, North Hero, Strafford, Westford, Concord, Craftsbury, Marlboro and Wolcott.

Federal Assistance

Federal grants and appropriations are currently funding three large infrastructure projects in Vermont. The ConnectVermont Fiber Project, which will place fiber optic cable in interstate highway rights-of-way, is funded through a ten million dollar Federal Highway Administration High Priority earmark obtained through Senator Leahy. The North-Link project will construct fiber rings around Vermont's six northern counties. Senator Jeffords worked closely with the Economic Development Administration, which has provided $3 million in grants for the North-Link project. Senator Leahy announced a $500,000 federal appropriation for the project in December 2005. Both the North-Link and ConnectVermont projects do require local match, and each have particular limitations and requirements linked to the project, such as the requirement that the ConnectVermont dollars be spent on routes that will support Intelligent Transportation Systems (ITS). However, they do make financially feasible infrastructure projects that would not be on their own. In both of these cases, federal grant money has been available for "middle mile" projects (see below). While this type of project may support the development of "last mile" projects they do not provide broadband access directly to residences and small businesses.

The Northern Community Investment Corporation (NCIC) is currently developing a "middle mile" project to bring broadband connectivity to the Northeast Kingdom and the North Country of New Hampshire. The project will ultimately use three fiber links that will provide a redundant wireless connection and an opportunity for Wireless Internet Service Providers to compete for customers in northern Vermont and New Hampshire. The US Senate, with the help of Senator Leahy, has awarded $600,000 for the Vermont portion of the project. The funds for this project are now in the process of being appropriated.

Cost and Availability of Infrastructure and Inputs

Expanding the availability of broadband infrastructure costs money. Just how much it costs depends on the type of broadband system.

Cable

Nearly all cable infrastructure in Vermont has been upgraded and is capable of delivering broadband services. Therefore, the main cost of expanding cable modem services is the cost of extending cable lines. Although sometimes disputed by cable companies, the Public Service Board (PSB)-supervised cost per mile charged to customers who pay for cable line extensions provides an indicator of the cost of these expansions. The cost for cable line extensions is approximately $20,000 per mile[22]. This relatively high cost presents a barrier to expanding into low-density areas. Cable line extensions in Vermont are currently mandated without customer contribution at densities that range from 14 to 25 homes per mile[23].

Telephone

Upgrading telephone networks to make available DSL broadband generally involves a variety of steps, from installing DSL electronics in central telephone serving offices and remote cabinets (or remote terminals) in the field, running fiber optic cables to those locations, and eliminating

[22] Based on data reported in Adelphia's 2005 Annual Report.
[23] Comcast will be making additional investments to build more than 1,000 miles throughout Vermont to fulfill Adelphia's commitment.

various imperfections or impediments on the copper loops that run to homes and businesses. Since DSL uses copper lines (or loops), but only works well over limited line lengths, a major disadvantage of a DSL upgrade is limited loop lengths. Serving customers throughout a telephone exchange generally requires that telephone companies increase the number of remote terminals, which is a hurdle in parts of telephone exchanges with small numbers of customers. If this is not done, scattered pockets of unserved customers will remain. Even when a telephone central office or remote terminal is equipped to serve DSL, customers at the long end of a long line will not be able to receive DSL service. However, DSL does not require that companies construct a new line to each customer and telephone lines are ubiquitous, which can sometimes make DSL one of the more cost-effective ways of expanding service. The cost of upgrades varies from company to company, depending on factors such as the service territory and quality of the telephone plant. According to a recent National Exchange Carrier Association (NECA) estimate, the upgrade cost in central office and midrange service areas is $988-1,033 per line[24].

Fiber

Fiber-to-the-Premise networks are a method of delivering broadband that builds brand new networks using optical fiber systems throughout. A large barrier to building this type of network is raising the initial capital required. Costs vary depending on how many subscribers there are. Burlington Telecom estimates an average cost of $3,000 per subscriber with a 25 percent take rate in the city of Burlington (i.e. about 5,000 connected subscribers). In many rural areas the average cost per subscriber would likely be closer to $4,000.

There are three main components of cost: a) the fiber distribution network; b) the main hub or central office; and c) connection of a given customer from the home/office to the fiber cable on the road. Because of rough terrain and lower population density, the cost of deploying a fiber distribution network (the fiber cables which go down every road past every home and business) is higher in rural areas, but this is the only significant cost difference between rural and urban areas. The Hub or "Central Office" where all the "intelligence" of the network is concentrated (computers, switches, routers, cable TV head-end, etc.) is a major cost but is no different in rural as opposed to urban areas. Similarly, the cost of hooking up individual customers to the cable on their road is significant—$1,700 - $1,800 per customer—but is only slightly larger in rural as opposed to urban areas. Although the hub and equipment can be expensive, a fiber network is quite flexible and can serve customers at great distances. As few as 3 to 5 hub locations could serve the entire state of Vermont. Fiber networks also enjoy lower maintenance and operating costs than traditional wired networks, and are less expensive to upgrade to handle higher capacity services.

Wireless

Wireless broadband services have the advantage of often having the lowest up-front capital costs, which has made them an attractive option when capital is constrained. If license-free spectrum is used, there is no cost for the transmission medium (unlike the cost of copper wire, coaxial cable, or fiber optic cable). The equipment cost for a base station to distribute the wireless signal is relatively low, $25,000 to $36,000 per site, though a single site can cost $80,000 or more. Customer premise equipment (CPE) that communicates with the base station can run as much as

[24] http://www.neca.org/media/Packet_train_study_6_14_final.pdf, page 13 of 20.

$650 per subscriber. An additional cost is often the cost of a visit by a technician to install and configure the customer premise equipment, which can exceed $200 per subscriber. Installation costs and CPE costs are higher than for DSL and cable modem, where large volumes have driven down customer premise equipment costs and where the equipment is generally customer-installed. These installation and customer equipment costs are larger than most customers are willing to pay up front, and WISPs must either finance the cost for their customers or limit their potential market. Widespread adoption of a wireless broadband standard such as WiMax would likely reduce the per-unit cost of customer equipment and make it possible for users to self-install, as is often now done with home wireless networks. Although wireless broadband has one of the lowest up-front costs, it is also is a technology undergoing rapid evolution, and investments made in wireless broadband networks are more likely to require an upgrade sooner than other major alternatives.

Internet Backbone and the "Middle Mile"

The cost and availability of Internet backbone access is an issue that cuts across different types of broadband service providers. The Internet backbone refers to a central connection to the core Internet. Broadband service providers supply a connection between their end users and the Internet backbone, and typically pay for access to these backbones unless they happen to own one. "Middle mile" networks connect local broadband networks to regional and national networks where a large volume of Internet traffic is aggregated.

The cost of accessing Internet backbone networks is an important, if not defining, cost element for broadband networks. For a small local network serving a relatively small number of customers, what the provider must pay for "backhaul" is a significant driver of what they must in turn charge and how much capacity they are able to provide to their customers. There can be a substantial difference in the price of high volume Internet access between national access points and in Vermont. In locations such as Boston, high volume backbone Internet access is available for as low as $10 per Mbps per month. Until recently, the price of high-capacity Internet access delivered to locations in Vermont was as high as $300 per Mbps per month. Increased competition brought about by increases in the number of networks connecting Vermont to locations such as Boston or Albany, NY, has caused prices for some customers to fall below $100 per Mbps per month. To access these lower prices for high-capacity Internet access, it is still necessary to be located on or very near one of the high-capacity middle mile networks that cross the state. Otherwise, there are additional costs to transport local Internet traffic back to one of these networks via leased lines.

Pole Attachments

Access to utility poles is an essential requirement for providing wireline broadband services in Vermont for service providers who do not own poles (primarily cable companies and competitive telephone companies). The ability to attach to utility poles could also be useful to Wireless Internet Service Providers. Vermont permits pole attachments at regulated rates that are designed to allow pole owners to charge only an amount that is proportional to the pole space used. This facilitates expansion of service. Public Service Board Rules also set limits on the amount of time that pole owning utilities have to respond in cases when a pole requires replacement or other work to accommodate an attaching entity. Currently these rules only benefit companies that are regulated by the Public Service Board and do not cover most WISPs.

While there has been some interest by WISPs in attaching to existing utility structures, there has not been much activity in this area, and the rules are not as clear.

Towers and Other Antenna Attachment Sites

For wireless broadband providers, the ability to find sites that can host antennas is a key part of expanding service. Options are generally greater in areas with a greater density of people and buildings. Few new towers have been built just to host wireless broadband service. Instead, WISPs have relied on existing towers or other buildings that are situated such that their radio signals will reach customers. The Department of Information and Innovation (DII) administers requests to site antennas on state properties. DII is working to improve the process, but delays within other agencies tend to frustrate providers, who generally consider dealing with the state "not worth the wait."

Land Use Permitting Process for Wireless Services

Both Act 250 and municipal zoning regulate the placement and attributes of some facilities for wireless communications (including some of those that provide wireless broadband services). These regulations are intended to reduce the potential for adverse impacts from wireless development. However, they may also limit some options for increasing the availability of wireless broadband services. The need to complete local and/or state permitting processes may impact the development of wireless broadband services by delaying or making the process of siting a new facility more expensive. Small Wireless Internet Service Providers (WISPs) generally have limited capital and personnel. Generally, they cannot afford to build large towers and have a financial need to quickly get new sites up and running with customers that generate cash flow. However, due to the way the law is written, even a relatively low-cost, low-impact new structure may trigger the need to obtain a permit, potentially reducing the number of these new sites proposed and the rate at which they are sited.

Transportation Rights of Way

There are three distinct processes to obtain approval and place facilities under different classifications of transportation routes. Different rules for compensation apply to limited access highways, other highways, and state owned rail routes. In all cases, there are restrictions on the type and placement of structures related to safety concerns.

State Highways

The Agency of Transportation (AOT) must issue a permit for any work done within state highway rights-of-way[25]. For state highways, there is no charge to process or issue a highway permit for utilities (including providers of communications services to the public). These companies do not need to pay a lease payment for the use of state highway rights-of-way, which reduces the cost to provide service.

Interstate Highways

When facilities are placed in limited-access highway rights of way, Federal Highway Administration rules must also be followed[26]. These rules generally require facilities which do not have a "highway use" to be placed on the outer edge of rights of way, such as near the fence

[25] 19 V.S.A. § 1111.
[26] 23 C.F.R. § 1.23 and 23 C.F.R. § 645 Subpart B.

line; this location frequently presents environmental or physical obstacles to the placement of these facilities. There is also a requirement to charge a fair market value for access to the right-of-way.

The AOT Utility Accommodation Policy provides the procedures governing installations and construction within the rights-of-way of the state highway system[27]. AOT is currently revising its Utility Accommodation Plan (UAP), and has prohibited wireline facilities in the Interstate right-of-way pending its completion. AOT anticipates that the modified UAP will permit placement of wireline telecommunication utility facilities within limited access highway rights-of-way in Vermont without location restrictions, but only if they have a highway purpose or are part of a shared resource facility which includes a highway purpose[28].

Rail Rights of Way

AOT authorizes and issues licenses for utilities that place facilities in state owned railroad rights-of-way. Unlike the policy for road rights-of-way, state statutes obligate AOT to collect a fair market value for the use of the right-of-way[29]. A Rail Utility Master License Agreement is required by the AOT Rail Division and the railroad operator to use or deploy utilities along state owned rail rights-of-way, and the negotiation of these agreements has sometimes been a time-consuming process.

Impacts of State and Federal Regulation

Another major factor affecting broadband deployment in Vermont is the regulatory environment. State and federal regulators have a wide array of regulatory authority that can have a substantial effect on broadband deployment. Broadband Internet services and Internet infrastructure investments are not expressly regulated by the state or federal government. The Federal Communications Commission (FCC) and Congress have thus far adopted a relatively hands-off approach regarding the Internet.

PSB Preempted by Federal Law

Federal rules prohibit Vermont from regulating Internet service. A series of FCC decisions have classified broadband services as interstate information services rather than as intrastate telecommunications services, and have limited the state's authority over broadband service. Prior to these FCC determinations, the PSB could have required broadband deployment and regulated the terms and conditions of that service.

Furthermore, since investments telephone companies make to provide DSL service are considered interstate, such investments are ordinarily excluded from telephone ratemaking in Vermont. This complicates state efforts to recognize investments in broadband as part of the ratemaking process. The state has recognized such efforts to an extent, such as through alternative regulation.

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[27] Ibid.

[28] Actual permits for such work are required under 19 V.S.A. § 1111. They are required for conformance with 23 C.F.R. § 1.23, Part 645, Subpart B, and are adopted by the Agency of Transportation. These regulations and procedures are intended to provide for the safety of the traveling public, and to promote a coordinated relationship between highway and utility use so as to protect the substantial public investment in our highway system.

[29] 5 V.S.A. § 3406(a) and 19 V.S.A. § 26a.

The Federal Cable Act limits the PSB's authority to require specific infrastructure investments. The PSB cannot generally mandate specific facility deployment, although it can, and has, set standards that specify when a company must expand its service to nearby, unserved customers.

Cable Line Extensions

Extending cable's reach expands broadband availability by extending current cable networks. PSB rules require cable companies to extend their lines without customer contribution where there is an excess of 25 homes per mile, except when specified differently in the company's certificate and tariff[30]. Larger cable companies are building down to a density of 12-18 homes per mile. These requirements that extend cable television coverage also have the effect of extending broadband availability. In addition to line extension requirements of the company's Certificate of Public Good, Comcast has inherited an obligation from Adelphia to build over 1,250 additional miles by 2009. Adelphia had preciously reached an agreement with the Public Service Board to build these miles as part of a dispute settlement.

Cable line extensions help improve broadband coverage in small increments. However, these policies are not effective in bringing broadband to the least densely populated remote and rural areas that currently lack cable television service.

Verizon Alternative Regulation

The most substantial area of telephone regulation that will affect deployment of broadband in the near future is Verizon's alternative regulation plan. Verizon's recently approved revised alternative regulation plan will substantially improve access to broadband in Verizon Vermont territories. In the plan, Verizon agreed to extend broadband availability to 65 percent of its Vermont customers by the end of 2007, 75 percent by 2008, 77 percent by 2009, and 80 percent by 2010 (currently only 56 percent of Verizon customers are DSL qualified). The plan gives Verizon great flexibility in both the technology used to provision broadband and the areas to which it is deployed. Verizon can choose to concentrate its efforts in certain areas or scatter deployment across the state as long as it meets the goal of 80 percent coverage by 2010. The company also has the option of utilizing various technologies to extend broadband coverage, including DSL and methods not used today by Verizon in Vermont such as terrestrial wireless and fiber. The PSB's order approving the agreement between Verizon and the Department of Public Service also makes clear that any company which might purchase the Verizon territory in Vermont must also fulfill this broadband deployment obligation.

NECA Pool

Independent telephone company participation in national cost and revenue pooling has resulted in extensive deployment of broadband in Vermont's independent territories. Independent telephone companies are small rural carriers that, in the absence of national pooling, might have trouble making individual investments in broadband. Fortunately, Vermont independent telephone companies are a part of the National Exchange Carrier Association (NECA), a national group of telephone companies which pool costs and revenues. This pool helps smooth costs across carriers and makes it easier for small rural companies to earn a return on network

[30] PSB Rule 8.313.

investments, including upgrading their networks for broadband. The NECA pool has been a critical component of broadband deployment for Vermont's small independent telephone territories.

Federal Universal Service Fund

The Federal Universal Service Fund (FUSF) brings dollars to the state to develop important infrastructure. The current FUSF program favors broadband expansion more rapidly in independent telephone company exchanges. One problem is that, even though Verizon is serving rural customers in Vermont, they get relatively little FUSF support because of the size of the overall company. Furthermore, the current rules of the FUSF do not allow telephone companies to use FUSF money to directly support broadband investments. However, "backdoor" support is common through the support of investments that support both telephone and broadband services.

Regulation of Small Telephone Companies

Recent legislation, resulting in 30 VSA § 227d, has also made it easier for Vermont's independent telephone companies to offer bundles of services that include broadband. Independent telephone companies have reported that they have been enjoying better than expected success with recent bundled offerings; the most popular packages include DSL. These new bundles have increased customer take rate of broadband, though it is difficult to tell how this new legislation affects deployment.

Local telephone companies charge long distance carriers fees, called access charges, for telephone calls that begin or end at the local telephone company exchange. These charges to long distance carriers, and ultimately to long distance customers, have traditionally helped maintain reasonable rates for local telephone service. Access charges for exchanges served by small local telephone companies are substantially higher than analogous charges in Verizon exchanges. By this mechanism, all long distance customers help to support basic local telephone rates in rural areas.

The 1996 Telecom Act

The1996 Telecommunications Act (the Act) requires Verizon to lease its lines to competitors at wholesale rates. Competitive companies can lease wholesale loops in order to provide DSL. In a best-case scenario, this would encourage competition for broadband across Verizon's territories. In practice, however, competition has not been realized for many customers. Wholesale prices for DSL-capable loops are twice as high in the most rural areas of Vermont because the Act requires geographically de-averaged wholesale rates. This cost structure encourages competition in the most densely populated areas. There are simply more dollars to be made in these markets.

Verizon Vermont
Wholesale Loop Rate

Rate Zone 1	Urban	$ 7.72
Rate Zone 2	Semi-Urban	$ 8.35
Rate Zone 3	Rural	$ 21.63

Source: Verizon SGAT, ADSL Qualified Digital Two Wire Link

Federal Spectrum Policy

The FCC's policies on radio spectrum have shaped how WISPs have been able to offer service in Vermont. The FCC has made a number of spectrum bands available for use on an unlicensed basis. This has meant that WISPs in Vermont have been able to enter the market without incurring the time and expense of buying licenses for spectrum. For most deployments, the performance of this spectrum in Vermont has been adequate, although there may be some real limits on the ability of currently used unlicensed spectrum to support higher speeds. Some WISPs have investigated the use of licensed spectrum, which would allow them to operate at higher power, reach more people with fewer sites, and offer higher data transmission capabilities. Licenses are, however, another expense and therefore present a potential barrier, and there are limited opportunities to license spectrum. Furthermore, the FCC's requirements for license-holders in many key frequencies can be met without extensive build-out into rural areas.

Unregulated Entities

Some of the providers of broadband service have limited regulatory constraints. Wireless Internet Service Providers, for example, are not required to obtain a Certificate of Public Good like a telephone or cable operator. WISPs consequently have no regulated deployment requirements. Satellite Internet providers are also not regulated by the state and have no deployment requirements. However, we have yet to see widespread adoption of satellite-based Internet services.

Competition and Marketing

Competition has spurred the deployment of broadband services in Vermont as it has in other locations. An early factor that helped to motivate cable television companies to roll out cable modem services was a desire to offer a service that their direct broadcast satellite competitors could not. Competition with satellite helped to motivate upgrades to cable systems that enabled new digital video services and broadband. Another factor that motivated early deployment of cable modem service was the desire to gain the first-mover advantage in the new market for broadband Internet access. In most places in Vermont, cable companies captured this first-mover advantage, although in a few independent telephone company territories like VTel and Waitsfield and Champlain Valley Telecom it was the telephone company that first brought broadband to customers. First movers and companies that have been in the market longer tend to have higher penetration rates than those who have come second and later.

Intermodal Competition

In parts of the state and the country where both cable and telephone providers offer broadband service, there has been competition on speed of service and price, with providers offering either increased data transfer rates, lower prices, or both, as each competitor seeks to claim market share from the other and from dial-up Internet access. Commonly available nominal data

transfer rates are now as high as 6 Mbps, and high-speed services are available for as low as approximately $17/mo.—although not at the same time. The original broadband services tended to be offered at $40-50/month. Current competition and the lower prices it brings have lured more and more people to broadband. Many cable and telephone companies are offering or moving toward being able to offer customers "triple play" bundles of telephone, high-speed data, and video services, with the objective of being able to generate increased revenues per customer and discourage customers from leaving for a competitor.

Video

In some infrastructure upgrades that enable broadband, video service, with its relatively high levels of revenue per customer, is a key leg financially to support the cost of the infrastructure. Telephone companies who wish to offer video services need to make greater incremental investments in their infrastructure than cable companies who wish to offer telephone service over a broadband-capable cable system. Ironically, competition between cable and telephone companies across the country has in some ways placed barriers to greater investment in broadband infrastructure in Vermont, as the increased competition in major metropolitan markets can put pressure on providers with a national footprint to spend more capital in those markets.

While many locations in Vermont have two or more broadband competitors, there are substantial portions of the state that still have only one or even zero terrestrial (non-satellite) providers of broadband service. In a growing number of Vermont communities without service, the demand aggregation process facilitated by the Vermont Council on Rural Development has been followed by a process in which a local committee conducts a search for a provider to serve the identified demand. To date, communities have almost always had the choice of only one or a very small number of WISPs, and have not been successful in attracting other types of service providers. Sometimes the options that these communities have been presented with have a questionable track record or none at all, and some, such as a project in Marshfield/Plainfield, have gone through several iterations of searching for a service provider capable of delivering service to the community.

Marketing and Awareness

While there is a demand for broadband service, marketing the service is important for speeding adoption and improving the commercial viability of broadband deployments. Incumbent telephone companies, cable companies, and dial-up ISPs have had a relative advantage because of their existing customer relationships that they can use to promote migration to broadband service, as well as greater financial ability to promote their services in the mass media. Start-up companies such as the WISPs have had to build their customer base from scratch. The community demand assessment efforts have been relatively more important for these companies, as it puts them in touch with an interested customer base.

Conclusion

This paper has briefly examined many of the variables in the market for broadband Internet services. The most common ways Americans obtain broadband connection are through their local telephone and cable companies, but for various reasons these broadband choices are less available in rural areas. A mass-market broadband service of one form or another is available to more than 85 percent of Vermonters, but availability is much lower in some parts of the state,

and the lack of truly universal availability even in the most populous counties of the state is a matter of great concern. Where broadband is available, Americans and Vermonters are subscribing.

Low population density and unfavorable terrain are obvious factors that slow down broadband deployment in the state. Overcoming the cost of providing service to rural areas is a key issue. Technologies such as cable and fiber require large expenditures per customer or mile to expand service. DSL can be added to existing telephone plant, but without still additional investments, some customers at the end of long lines will not receive service. Viable business plans for these costly investments are more difficult to find. Where they can be found, availability of capital can be an issue. Large multi-state corporations have competing demands on their capital, and small start-ups may not have access to the level of capital that would enable them to expand rapidly. Grants to provide broadband service to end-users are small and rare. Loan programs are available to fund broadband projects in rural Vermont, but competition for awards, difficult-to-meet program requirements, and other barriers have resulted in a limited effect on broadband deployment in rural Vermont.

In contrast, where there is substantial broadband deployment in Vermont, there is typically either a relatively densely populated community, or there is a locally focused service provider with an existing communications service that provides a reliable cash flow, as well as access to a substantial source of capital. The state, through regulatory settlements or other requirements, is helping to ensure that companies like Verizon and Adelphia/Comcast are making major expansions beyond what they likely would have done on their own initiative.

There has not been one single technology solution for providing broadband access. DSL and cable modem solutions have built on existing infrastructures and are additions to established services. Wireless has expanded broadband to locations that no other service has been able to reach. Fiber promises the ability to provide nearly unlimited capacity and lower operating costs. Each of these technologies has its challenges and limitations as well.

In order to bridge the still-remaining gap and bring broadband services to rural areas, it will be necessary to build on those factors which have delivered broadband service to much of Vermont, and address the challenges which still remain if we are to provide broadband services to all Vermonters. In particular, we will need to do what is necessary to support the capital investments in infrastructure and services need in our rural and difficult-to-serve areas. How to address these challenges is the subject of the companion to this report, *Access for All: Meeting Vermont's Broadband and Wireless Goals*.